W9132T-04-C-0013

Montana State University-Billings

Midpoint Project Status Report

Proton Exchange Membrane (PEM) Fuel Cell Demonstration
Of Domestically Produced PEM Fuel Cells in Military Facilities

US Army Corps of Engineers
Engineer Research and Development Center
Construction Engineering Research Laboratory
Broad Agency Announcement CERL-BAA-FY03

Billings Armed Forces Reserve Center, Montana

26 January, 2005

Executive Summary

The Center for Applied Economic Research at Montana State University-Billings has commissioned and is operating one (1) fuel cell system for the Montana Army National Guard. The fuel cell manufacturer is Plug Power of Latham, New York. Project subcontractors include the following organizations: Montana-Dakota Utilities (gas supply, unit installation, commissioning and maintenance), Ace Electric (wiring and interconnection) and Wagner Mechanical (plumbing and water management). The Plug Power unit we are operating is a GenSys™ 5CS, rated at a maximum output of 5kW. The current operating set point is 2.5kW.

The unit is configured to serve a portion of the base electrical load at the Billings Armed Forces Reserve Center, located in Billings, Montana. It is fueled by natural gas and operates in parallel with the existing grid-supplied power. The project is configured for heat recovery.

The host site point of contact is Major Mike Bricker. Major Bricker may be reached at: Michael.bricker@mt.ngb.army.mil.

The benefits of this project are multiple. Two primary benefits are gauging unit performance under what may be considered as extreme environmental conditions and the second is educational. Well thought-out and extensive mechanisms must be installed to maintain the flow of water into, through and out of the unit. Water management during extended periods of subzero temperatures will provide a challenge to the team. Secondly, many of the team members have expressed a strong desire to learn about the technology and are eager to participate in a successful demonstration. This is a positive experience for Montana.

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Proposal – Proton Exchange Membrane (PEM) Fuel Cell Demonstration of Domestically Produced Residential PEM Fuel Cells in Military Facilities

1.0 Descriptive Title

Proton Exchange Membrane Fuel Cell Demonstration at the Billings Armed Forces Reserve Center, Montana Army National Guard, Billings, Montana (Mountain Geographic Region).

2.0 Name, Address and Related Company Information

Montana State University-Billings
Center for Applied Economic Research
1500 University Drive
Billings, MT 59101
(406) 657-1763

Data Universal Numbering System (DUNS) Number: 079713608
Taxpayer Identification Number (TIN): 816001642

Montana State University-Billings (MSU-B) is a comprehensive, regional, public university serving the educational needs of Montanans and is accessible to all who are qualified. MSU-B is an affiliate of the Montana State University family of campuses and has a student body of approximately 4,800. MSU-B is located in the largest city in Montana, Billings, which has a regional population of 123,000.
The Center for Applied Economic Research is a research and service organization for MSU-B. Its mission is to provide research and analysis to support economic development in the Yellowstone region that includes central and eastern Montana and northern Wyoming. The Center provides research services in energy markets and technology through grants, industry partnership agreements, collaborative studies, and customized contracts. Our website is www.msubillings.edu/caer.

3.0 Production Capability of the Manufacturer

Plug Power, Inc.

Plug Power designs, develops and manufactures on-site electric power generation systems utilizing Proton Exchange Membrane (PEM) fuel cells for stationary applications. Plug Power's fuel cell systems are expected to be sold globally through a joint venture with General Electric and through DTE Energy Technologies in a four-state territory, which includes Michigan, Illinois, Ohio and Indiana. The Company's headquarters are located in Latham, N.Y., with offices in Washington, D.C., and The Netherlands. Plug Power's role in the Program will be to serve as fuel cell manufacturer and provide technical and operational support to Montana State University and its service provider.

Plug Power's manufacturing facility in Latham, New York opened in February 2000 and is comprised of 50,000 square feet of dedicated production and production test facilities. Plug Power employs approximately 100 personnel in its production areas. The production processes are designed around the principles of Lean Manufacturing, and use the Toyota Production System as a model. As such, planning and production is via a "pull system" that is, systems are produced only as orders pull demand for product through the production system. Lead-time for delivery is twelve weeks for large orders; smaller orders can be fulfilled immediately.

Plug Power Inc. is a designer, developer, and manufacturer of on-site, energy generation systems utilizing proton exchange membrane fuel cells for stationary applications. The Latham, N.Y.-based company was founded in 1997 as a joint venture of DTE Energy Company and Mechanical Technology Incorporated. Plug Power Holland was established in February 2000 as the first European presence of Plug Power. Plug Power's fuel cell systems for residential and small stationary commercial applications are expected to be sold globally through a joint venture with the General Electric Company, one of the world's leading suppliers of power generation technology and energy services. DTE Energy Technologies will distribute these units in Michigan, Illinois, Ohio and Indiana. Systems will be distributed in Europe through Vaillant.

Our primary contact at PlugPower is:

Mr. Vincent Cassala
518-782-7700 x1939
vincent_cassala@plugpower.com

The items and services to be provided by PlugPower include the following:

Quantity	Description
1	GenSys 5CS fuel cell system with Standby Capability (“Product”)
1	Service Agreement for Parts and Support
1	Shipment of GenSys 5CS and associated installation materials via flat-bed truck

4.0 Principal Investigator(s)

Mr. Brian Gurney
Energy Program Manager
Montana State University-Billings, Center for Applied Economic Research
Phone:(406) 657-2906 Fax: (406) 657-2327
Email: bgurney@msubillings.edu

5.0 Authorized Negotiator(s)

Dr. C.A. Carey
Director of Grants and Sponsored Programs
Montana State University-Billings
Phone: (406) 896-5872
Fax: (406) 657-2264
Email: cacarey@msubillings.edu

6.0 Past Relevant Performance Information

The Center is currently working on two distributed generation projects that involve fuel cells:

1. Solid Oxide Fuel Cell Demonstration Project
Sponsor: Montana-Dakota Utilities
Dollar Value: $400,000
Point of Contact: John Delvo, (406) 896-4241
Description: A partnership with Montana-Dakota Utilities, Global ThermoElectric and the Center for Applied Economic Research will result in the acquisition, installation, operation, maintenance, monitoring and removal of 2 SOFC's. The first unit will be a residential application while the second unit will be placed in a rural/remote setting.

2. Reducing Barriers to Distributed Generation
Sponsor: Montana Department of Environmental Quality through a grant with the US Department of Energy
Dollar Value: $100,000
Point of Contact: Mark Hines, (406) 444-6769
Description: The goal of this project is to identify a set of regulatory and business process best practices for the marketing, installation and servicing of small-scale distributed generation devices. One of the tasks in this project is to identify peculiarities with fuel cells, such as policies that encourage market adoption of fuel cell products through energy efficiency programs rather than renewable energy incentives. Simulations will be run to evaluate alternative business processes and identify best practices that minimize transaction costs associated with marketing, installing and servicing distributed generation units in residential and commercial settings.

3. Big Sky EDA Fuel Cell Project
Sponsor: Big Sky Economic Development Authority
Dollar Value: $54,000
Point of Contact: Dan Stevenson, CTA, Inc. (406) 896-6171
Description: Conducted analyses of the market for fuel cells, including a survey of households.

7.0 Host Facility Information

Military Facility Site 1:	Montana Army National Guard Billings Armed Forces Reserve Center 2915 Gabel Road Billings, Montana 59102
The Point of Contact is:	Major Michael Bricker, Officer in Charge Billings Armed Forces Reserve Center Phone: (406) 655-6220 Fax: (406) 655-6229 Email: michael.bricker@mt.ngb.army.mil
The State Facilities Management POC is:	Colonel Allan Stricker 406-324-3101 allan.stricker@mt.ngb.army.mil and Mr. Scott Cromwell, AIA, MANG 406-324-3102 scott.cromwell@mt.ngb.army.mil

Facility Electricity Provider: NorthWestern Energy

Fuel Provider: Montana-Dakota Utilities

Billings Armed Forces Reserve Center

- Designed in 1997-98
- Constructed in 1999
- 113,300 +/- square feet
- Facility is called the Billings Armed Forces Reserve Center
- Houses a US Marine Reserve Unit and 3 units from the Montana Army National Guard
- Facility includes spaces such as:
    - Mess Hall
    - Assembly Hall
    - Indoor Firing Range
    - Classrooms
    - Administrative spaces
    - Parachute drying tower
    - Military equipment supply rooms and weapons vaults
    - Etc.
- Anticipate constructing a 45,000 square foot addition to the building beginning within the next year +/-.

A digital front view of the host site is included in **Appendix A.**

8.0 Fuel Cell Installation

On 11 June, 2004, our team hosted the project Kickoff Meeting. This was the first time that the Montana Department of Military Affairs (DMA) had been given the opportunity to view the complete set of plans that were generated by the project engineering firm of record, Associated Construction Engineers (ACE) of Billings, MT. ACE had worked with the DMF before, and we wanted to contract with ACE to stay within this comfort zone for the DMA. Two representatives from the DMA, John Horn-Contracts Specialist and Scott Cromwell-Architect, joined us at the meeting.

On 14 June, DMA notified the team that there were 16 items that required further review/information/analysis/clarification. The "Design Review Record" issued by the DMA is located in **Appendix B**. Twelve of the sixteen items were able to be addressed by ACE, however the other four required the services of a structural engineer. To maintain the thread of continuity with DMA, we went to A&E Architects of Billings, who was a partner when the facility was originally constructed. Because of the workload at A&E, the project was delayed approximately 11 weeks. On 6 September, A&E issued a letter (**Appendix C**) to the team and DMA that satisfied DMA to the point where they were willing to go forward and issue a contract to the team to proceed with installation. The overarching concern for the DMA was that we did not hit or cut the thick reinforcing cables that are threaded inside the pre-stressed panels that comprise the exterior of the structure. As it turns out, the cables are 18 inches above the base of the panel and that is above where the holes were bored into the panel. The DMA/MSU-B contract can be found in **Appendix D.**

The Montana Department of Military Affairs is a great group to work with. Scott Cromwell, AIA, has been very helpful in providing access to the building and data contained in this report. Even though some time was lost, many of their ideas and suggestions are threaded throughout the project.

Additionally, the project would not be possible without the participation and support of Montana-Dakota Utilities. John Delvo, P.E., and many others were instrumental in the installation process and do a great job at operation/maintenance/repair of the unit.

The Installation Process

- **1 October to 10 November**
- **Pour Pad-**

Figure 1- !0" Pad with 4" drain

- **Bore Holes Into Host Site –**

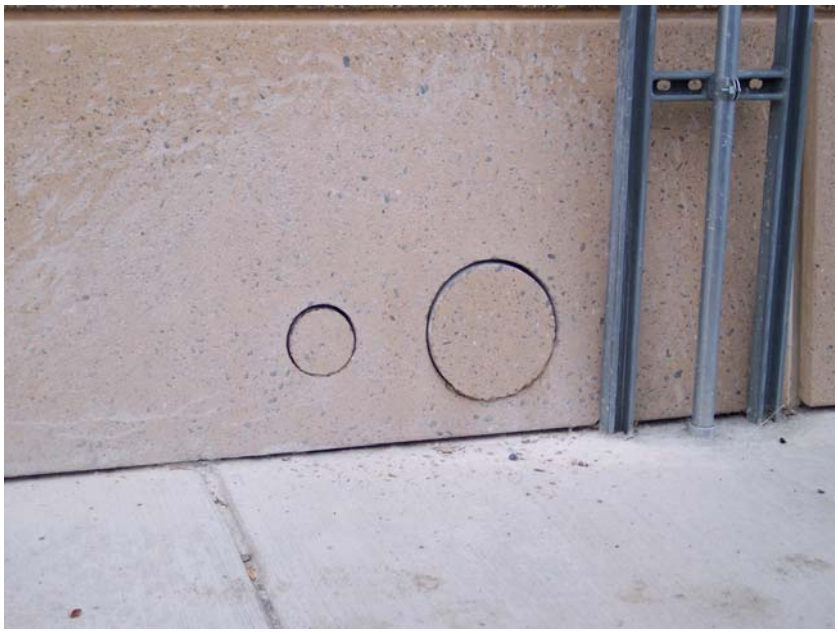


Figure 2- 3” and 10" Holes for Infrastructure

- **Set Unit**

Figure 3- Set Unit and center over drain

- **Run External Connections**

Figure 4- Drain, Fuel and Water Supply,CHP

- **Install Heat Exchanger for CHP**

Figure 5- Heat Exchanger Model G4408LD, www.taco-hvac.com

- **Interior Infrastructure, Partial**

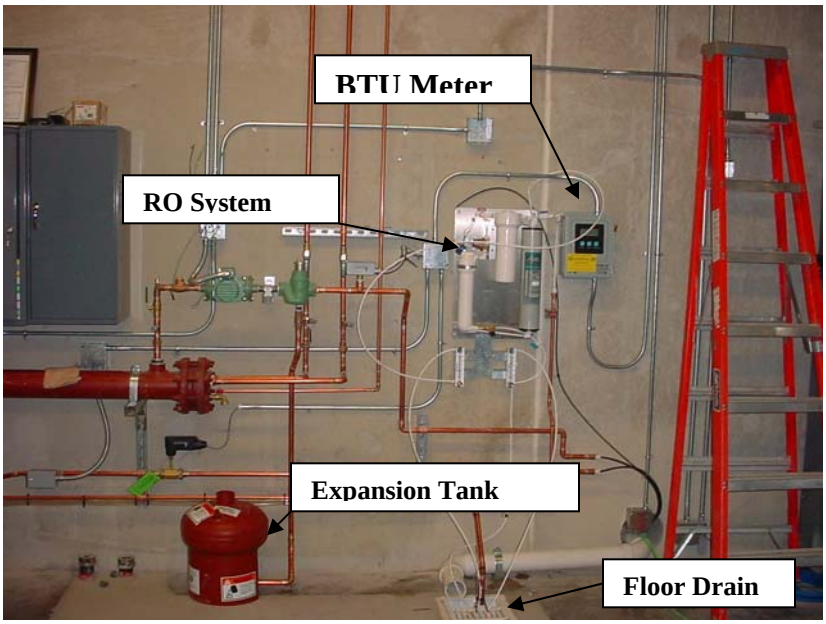


Figure 6- BTU Meter, ONICON System 10, www.onicon.com

- **Partial CHP Loop**

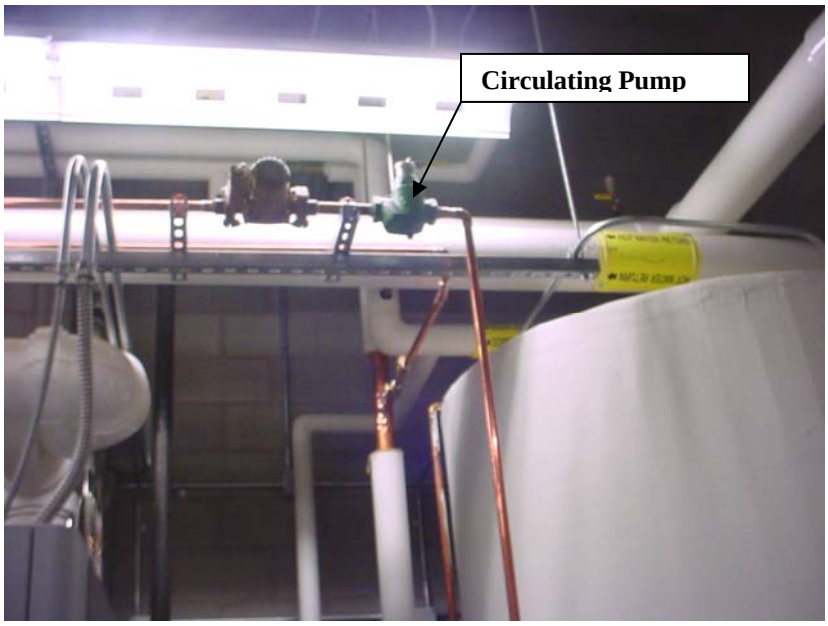


Figure 7- Partial CHP Loop to Boiler, Recirculating Pump Model 009, www.taco-hvac.com

Figure 8- Electric Meter and Grid Disconnect Switch

- 11 and 12 November
- Unit Prep

Figure 9- Install Fuel Cell Stack

Figure 10- Thermonal added to Unit

Unit Startup

Startup was initiated on 11 November, 2004 at 8:00 am. Two, Plug-trained MDU technicians were on site as was a Plug-trained PE for MDU. Success to startup was approximately 20 hours in duration and was completed at 6:00 am on 12 November. The team dealt with the following sequence of events during this time:

Problem 1

- Warning 404, Timeout Hum Fill Alert
- **Failure-** Polishing hose leaking on entry side
- **Fix-** Reinsert hose into filter/fitting
- **Possible Cause-** Jarred loose during shipping?

Problems 2-5

- Shutdown Code 333, Process Exhaust Temperature High
- **Fix-** Restart
- **Lesson Learned-** Discovered that DI tank automatically empties itself when the temperature sensor senses a temperature of something less than 40 degrees. Since the ambient temperature was dropping into the 20's during this process, we found ourselves literally starting over to fill the DI tank and the humidifier to bring the unit to the "running" state. Each iteration cost us approximately 4 hours.

Note: Since the temperature was going to drop into the low 20's on this night, about 2 am MDU went and purchased 2 1500 watt electric heaters and two 12' X 14' tarps. We tented-in the fuel cell for about 5 hours to get it through the coldest part of the night. Our fear was that water had already been circulating through the various hoses, pumps, sensors, etc., and we did not want ice to form because we were not in a "full run" mode.

We did not experience any difficulty with the local permitting process. It was helpful that the various city departments (Building, Fire, Water, etc.) were contacted earlier in the year and had a chance to ask questions and review unit spec data that was provided by Plug. The cost of the permitting process was $1,396.

Man-hours needed to complete the installation-

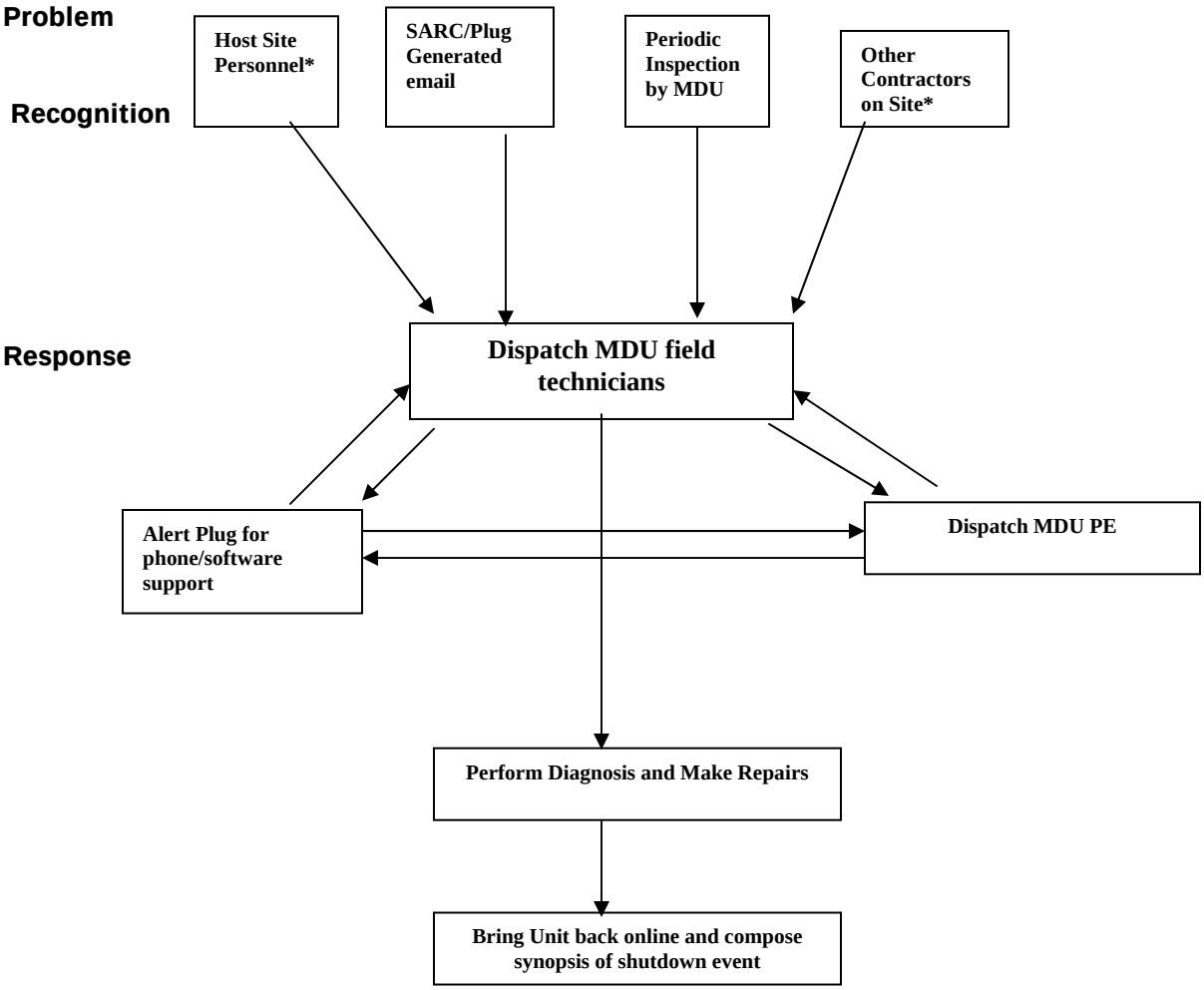
Company	Man-hours
Montana-Dakota Utilities	59.5
Ace Electric	130
Wagner Mechanical	120
Total	**309.5**

The fuel cell is feeding an electrical panel in the mechanical room which serves the boilers, pumps, condensers and other mechanical equipment. Hot water is being recovered and contributing to the heating needs of boiler system.

NorthWestern Energy, the host site electricity provider, chose not to pursue a formal interconnection agreement. Their largest concern was that the unit "have an electric disconnect installed to prevent "islanding" the system (feeding electricity into the grid when the NorthWestern system is down). The unit has the ability to terminate its electrical output when the grid is down, and this has already been tested at the site. Additionally, there is a manual breaker which is labeled and located next to the unit. The OK to go forward with the installation can be found in **Appendix E.**

The fuel cell power set point is 2.5 kW and the current fuel consumption is approximately 960 cu.ft./24 hours. The only other ancillary equipment that is directly tied to the unit is an electric meter, a gas meter and a BTU meter.

The current operating procedures are laid out as follows:



- MDU has trained 2-3 people in the military who work at the site on a frequent basis to investigate and perhaps record some of the data generated by the instruments and gauges as they walk through the area on their daily routine. Additionally, our mechanical contractor will be on site for several months working on a facility expansion at the site. Their personnel are instructed to observe the unit and report any suspected malfunctions as they go about their daily work.

The engineering drawings are included on this CD as a PDF file.

9.0 Electrical System

The fuel cell electrical system is dual function, capable of grid parallel and/or standby operation. This fuel cell installation is operating in the grid parallel configuration. This is the standard operating mode of the fuel cell. The system generates power at a fixed set point of 2.5 kW and sends it to the facility. Unused power is sent to the grid or, if more power is needed, it will be taken from the grid. This is done by back-feeding a 50-amp breaker in an existing electrical panel. In this type of interconnection, if the grid fails, the system will safely isolate itself from the grid. Upon return of the grid, the system will synchronize itself and reconnect with the grid.

Fuel cell output is 120 VAC @ 60 Hz, single phase line to neutral with a separate ground. The system is considered a utility interactive current source which automatically synchronizes itself to the grid's voltage and frequency.

The typical monthly load of the host site in support by the grid is 47,753 kWh/mo.

The fuel cell is rated for 5 kW (5 kVA) maximum, and 10 kVA for 5 seconds of overload conditions. The minimum set point is 2.5 kW (2.5 kVA). However, the system will follow any 0 to 5 kW load at the critical load panel in standby mode. The system has a unity power factor, pf = 1.0.

An automatic transfer switch is internal to the inverter which is designed to automatically isolate itself if over/under voltage is detected. Islanding protection is certified by Underwriters Laboratories to the UL 1741 standard.

The inverter has a microprocessor based controller that senses the grid, feeds the signal back and outputs the matching synchronized signal.

System controls are internal to the system and are designed and manufactured by Plug Power. These controls are microprocessor based. This fully integrated system is self controlling.

The electrical portion of the installation process came along rather well. We would have preferred that the installation of the electrical infrastructure be completed 24 hours earlier than when it was completed on 11 November, however, in defense of the electrical contractor, they did stay into the evening to ensure that there were no electrical glitches on the road to startup. It should also be noted that the MDU PE on site during the installation process was able to suggest to the journeyman electrician what the ideal location was for meters, manual disconnect switch, etc.

The electrical scope of the installation included:

- 120v incoming line voltage
- 120v outgoing load voltage fed into the electrical panel which serves the boiler room mechanical loads
- 24v control wiring for pump controls
- 120v power wiring to the circulation pumps
- 48vdc data line for monitoring by Plug Power
- 120v electric heat tracing on the exposed water lines
- 120v electric hour-watt meter to monitor power output
- Various conduit, copper wiring and steel fittings

10.0 Thermal Recovery System

1. Provide a complete description of the fuel cell thermal recovery system
What is the CHP heat recovery loop and can the system be operated without one installed?
The CHP heat recovery loop is a customer-supplied system that circulates a heat transfer fluid (typically propylene-glycol/water mixture) from the fuel cell to the customer-supplied system using the heat (existing domestic hot water tank). The fuel cell system is designed to operate normally if there is no CHP loop installed or if the customer demand at any time is zero. The excess heat generated by the fuel cell will simply be discharged through the existing radiator.

The system should be designed to meet the following specifications:

Flow: 0-10 gpm (1-2 gpm will maximize heat reclamation from the fuel cell – **we are balanced at 1 gpm)**
Pressure: <= 30 psig
Temperature: (installation specific) with a flow rate of 1-2 gpm, the return temperature to the customer-supplied system will be approximately 140°F
Available heat:

- 11,200 BTU/hr @ 2.5kWe

2. Define the fuel cell thermal output, and the thermal loads supported by the fuel cell.
Temperature: (installation specific) with a flow rate of 1-2 gpm, the return temperature to the customer-supplied system will be approximately 140°F – **we are at 133 degrees F.**
Available heat:

- 11,200 BTU/hr @ 2.5kWe

3. State the operating modes of the thermal recovery system, continuous, intermittent, seasonal, etc.
Intermittent/Continuous: Depends on the demand for heat from the domestic hot water tank – excess heat will be rejected through fuel cell radiator.

The fuel cell system is designed to operate normally if there is no CHP loop installed or if the customer demand at any time is zero. The excess heat generated by the fuel cell will simply be discharged through the existing radiator.

4. Describe the interconnection process of the fuel cell thermal recovery system to the facility.
The CHP heat recovery loop is a customer-supplied system that circulates a heat transfer fluid (typically propylene-glycol/water mixture) from the fuel cell to the customer-supplied system using the heat (existing domestic hot water tank).

Piping connections will be made from the domestic cold water line to the installed heat exchanger tube bundle. This cold water will be heated by a closed-loop propylene-glycol/water mixture which circulates from the fuel-cell through the heat exchanger tube bundle and returning back to the fuel-cell. The result is domestic hot water which will tie back into the existing storage tank adding more hot water to the system.

5. Provide photographs and engineering design drawings if available.
Digital photographs are included above and the engineering drawings are included on this CD as a PDF file.

11.0 Data Acquisition System

All operational data is sent automatically by the system (once per day) via modem/dial up connection to Plug Power where it is entered into the fleet database. Also, during every system shutdown, the unit automatically reports to Plug Power it's status, transmits data and a service call is then made.

Complete system operational data can be obtained directly from Plug Power or downloaded by a trained service technician with a laptop and RS232 connection cable. This data can be used for reporting and/or troubleshooting. Typical data used for reporting (non-sensitive) are run hours, power output, gas consumption, efficiency and availability.

The Billings, MT office of the National Weather Service is supporting the project by providing the hourly observation data in proximity to the host site. An Excel file attached to this submission contains the captured data on an hourly basis of numerous environmental parameters for the month of November. Note that some observations may be more frequent than by the hour if environmental conditions are in the midst of change.

MDU did install a standard gas meter upstream of the fuel cell, an electric meter downstream for the fuel cell and a Btu meter. These three devices will be read once a week and compared with the operational data that Plug is obtaining.

Fuel Cell Performance as of 4, December (provided by Plug Power)

Run Time (hours)	718
Run Time Cumulative (hours)	718
Time in Period (hours)	744
Availability (%)	97%
Energy Produced (kWe-hrs AC)	1755.76
Output Setting (kW)	2.5
Average Output (kW)	2.45
Fuel Usage LHV (BTU's)	2.30E+07
Fuel Usage (SCF)	2.28E+04
Electrical Efficiency (%)	26.07%
Thermal Heat Recovery (BTU's)	5526000
Heat Recovery Rate (BTU's /hr.)	7696.486023
Thermal Efficiency (%)	24.04%
Overall Efficiency (%)	50.11%
Number of Scheduled Outages	0
Scheduled Outage Hours	0
Number of Unscheduled Outages	1
Unscheduled Outage Hours	4

12.0 Fuel Supply System

The GenSys 5 kW fuel cell system at the Billings Armed Forces Center is fuel by natural gas. The gas that supplies unit is ½ "schedule 40 black pipe. The gas pressure that is supplying the unit is at 4 OZ. or approximately 7 "of water column. There where no challenges, changes or deviations from the proposed plan. This unit installed no different than installing a natural gas furnace for a home.

13.0 Installation Costs

	Demonstration Budget as of 12/15/04	
Fuel Cell Power Plant Costs:	**Budget**	**Actual**
Plug Power GenSys 5CS NG Fuel Cell	$55,000	$55,000
Service and Maintenance Agreement	$15,000	$15,000
Training at Plug Power for 2 MDU Techs.	$9,600	$6,621
Installation Costs:		
Wagner Mechanical	$5,280	$5,000
Engineering Services	$7,000	$7,000
Ace Electric *	$4,160	$8,320
Services and Equipment:		
Montana-Dakota Utilities		
Crane/Forklift	$500	$500
Nat. Gas Service. & Installation	$2,998	$613
Thermal Recovery Costs:		
Equipment Costs:	$3,000	
BTU Meter		$2,092
Maintenance Costs		
MDU Technicians	$8,906	$2,810
Project Management/Report Writing Costs:		
Principal Investigator	$20,793	$0
Travel Costs:		
Managerial travel	$3,895	$2,207
Technician Travel	$8,812	$3,958
Indirect Costs:	$13,766	$0
Other Costs:		
Fuel Cell Freight [1]	$500	$3,650
Electrical Equipment	$9,248	$9,248
City Plan Review Fee *	$0	$550
City Building Permit *	$0	$846
Catering *	$0	$66
Architectural Design Fee *[2]	$0	$1,000
Water Analysis *	$0	$200
Extra Copies of Plans *	$0	$100
Totals	$168,458	$124,781
Project Variance	$43,677	

***** Please recall that the original budget forwarded to CERL was slightly less than 200K. In subsequent communications, CERL requested that the budget be reduced. Our group will provide the monetary support if or when the project requires.

[1] We canvassed 2-3 trucking/freight forwarding companies about the cost to ship 2,000 lbs. from Latham, NY to Billings, MT. All of the quotes came in at $200-300. Hence, we placed $500 in the budget to cover freight and perhaps some additional insurance. Plug Power asked if we could take delivery in the first week of April 2004. We were surprised that Plug contracted with a private carrier whose entire load was comprised of 1 fuel cell. Therefore, we underestimated by $3,150.

[2] This fee is for the services of a structural engineer to address a request for information made by the Montana Department of Military Affairs.

14.0 Acceptance Test

On 16 November 2004, a representative of CERL, Mr. William Taylor, was able to witness and accept the performance of the fuel cell. Final touches were being installed on that date, such as adding insulation around the piping in the CHP loop. The fuel cell was operating in a "running" state for the following parameters: Stack, Inverter and Reformer.

On this date we also held a Demonstration Open House which was attended by some 85 people. Special guests included representatives of Montana's congressional delegation and the president of Montana-Dakota Utilities. We would like to thank Major Michael Bricker and the Montana Army National Guard for providing the space and support for this event. A copy of the Acceptance Meeting announcement is located in **Appendix F.**

Appendix

Appendix A

Appendix B

DMA-FMO **Design Review Record**

Project: **BAFRC - Fuel Cell**	Design Phase: **Construction Documents**
Comments by: **Scott Cromwell, Chris Denning, John Horn and Brian Moloney**	Date: **June 14, 2004**

Comment Number	Detail/Sheet or Spec. Section	Review Comments	Comment Response (for A/E use)
1	6/MPE1	Provide sleeve and/or core drill detail to penetrate existng precast wall panel at all locations. Size of sleeve or hole, sealant, and compaction of soil and gravel must be addressed. Verify height and location above footing that penetrations will be made. Coordinate detail with original building structural	To Be Addressed By A&E Architects SEE A&E ASK-001 DETAIL
2	26/MPE1	Show extents of concrete/asphalt cutting and removal interior and exterior.	To Be Addressed By A&E Architects SEE A&E ASK-002
3	26/MPE1	Provide section detail of 12" housekeeping pad.	To Be Addressed By A&E Architects SEE A&E ASK-003
4	26/MPE1	Dept. of Military Affairs has suggested that the surface around the housekeeping pad and bollards remain open with gravel fill. This will facilitate easier removal after one year of operation. Use 3/4" plus rock over landscape fabric. Please provide detail showing this.	To Be Addressed By A&E Architects SEE A&E ASK-004
5	26/MPE1	Provide detail showing asphalt patching and concrete replacement. Show rebar dowels necessary to tie new concrete sidewalk/apron to existing.	To Be Addressed By A&E Architects SEE A&E ASK-005
6	MPE1	3 PSI gas piping to be all welded. UG gas piping shall all be PE piping with factory riser sweeps.	Spec on drawings changed to reflect this material.
7	MPE1	Note 15: Is there any refrigerant piping?	None - Reference removed.
8	30/MPE1	One line diagram needs to be provided to ensure adequate shutoff/isolation and labeling due to two separate feeds to panel ILA. Dept. of Military Affairs recommends having a disconnect in the feeder adjacent to panel ILA from fuel cell.	Completed

DMA-FMO **Design Review Record**

Comment Number	Detail/Sheet or Spec. Section	Comment	Comment Response or Action Taken
9	26/MPE1	VTR penetration patched by building roofing contractor, R & L Roofing. Maintain existing warranty.	Note added to reflect this.
10	6/MPE1	HX-1 system requires ASME P&T relief valve.	Added to drawing.
11	6/MPE1	ET-1 not shown on piping diagram.	Added to drawing.
12	25/MPE1	No Backflow Prevention on CW makeup to deionizer.	Added to drawing.
13	MPE1	Controls for the system shall be separate from all existing building control systems. Dept. of Military Affaris strongly recommends Electro Controls.	As dicussed with Brian Maloney (7-7-04), Electro will connect to the DDC system
14	26/MPE1	Dept. of Military Affairs strongly recommends that sanitary system and new floor sink remain after project completion.	Noted on drawings.
15	MPE1	Listed codes in Note 1 are incorrect.	Corrected to current codes.
16	6/MPE1	Show capping/abandonment locations and details for underground piping.	All piping will be removed in its entirety.

Appendix C

A&E
ARCHITECTS

September 6, 2004

Brian Gurney
Energy Research
Center for Applied Economic Research
Montana State University – Billings
1500 University Drive
Billings, MT 59101

RE: BAFRC Fell Cell Project

Dear Brain:

We have reviewed the two sketches, SD1 ad SD2, provided to you from the Department of Military Affairs. The DMA have asked in their cover letter to have the openings through the exterior precast panel verified and confirmed. The idea to go horizontally through the precast wall and not under the footing and foundation is an excellent idea. We have reviewed the DMA provided details and find the EPDM covered enclosure pipe arrangement satisfactory. The dimensions shown on the sketch SD2 should be able to miss all the internal panel reinforcing. The (4) four core drilled holes will provide adequate room for the fuel cell piping and electrical lines. The EPDM enclosure at 1'-6" high will attach to the building where the precast panel has a vertical face and can be secured easily to the concrete sidewalk and precast panel.

Over the years, patching of the precast panel has been difficult because of the skills necessary to match the integral color of the precast concrete panels. The DMA recommendation to reinsulated the holes and provide a chrome or stainless steel cap plate is also our recommendation over attempting to plug and match the integral color of the concrete panel.

Of note, we have awarded our Naval Reserve Addition to the BAFRC to Hardy Construction and should see construction beginning this September. If they can help you with any of this construction please give Greg Hardy a call

I wish your research project great success.

Sincerely,

A&E Architects, P.C.

Tom P. Holden
Principal/Architect

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Appendix D

DEPARTMENT OF MILITARY AFFAIRS
P O BOX 4789
Helena MT 59604-4789
Contracting & Procurement 406 324-3106 FAX 406 324-3110 John.Horn@mt.ngb.army.mil

FACILITY USE AGREEMENT, DMA CONTRACT #500124

1. PARTIES

This agreement is entered into this 15th day of September, 2004, by and between the Montana Department of Military Affairs, located at 1900 Williams Street, Helena, Montana 59602, hereinafter referred to as the "Department" and Montana State University-Billings, Center for Applied Economic Research, hereinafter referred to as "University".

2. PREMISES DESCRIPTION

Montana National Guard facility designated Billings Armed Forces Reserve Center (BAFRC), 2915 Gabel Road, Billings, MT 59105.

The area authorized for installation of fuel cell includes only sufficient space outside the facility for the designated unit and collateral hardware and fittings, and installation of bollards.

Interior space is limited to area sufficient to accommodate necessary controls, hardware and fittings within Mechanical/Electrical Room 111.

3. PURPOSE OF AGREEMENT

The Department owns facilities located at Billings, Montana.

Therefore, Department authorizes University to install and operate one fuel cell system, details and specifications per proposal dated April 29, 2004, on the premises described in this agreement, on the terms and conditions set forth herein.

Contract requirements and specifications include all Construction Documents and amendments as approved by Department Architect.

University shall have installed at designated site one fuel cell system as described in **Proton Exchange Membrane (PEM) Fuel Cell Demonstration of Domestically Produced Residential PEM Fuel Cells in Military Facilities** and approved by Department personnel.

Installation shall meet construction standards, applicable codes, permitting requirements, local and federal guidelines.

Department must approve primary Contractor and sub-contractors.

Department personnel shall inspect the site after "core drill" but prior to major penetration of wall or inserting piping/conduit.

Primary contractor must provide sufficient performance bond or guarantee to continue in effect until removal of fuel cell, site renovation, final inspection and acceptance by Department. Upon removal of Fuel Cell, University shall ensure that site is restored to a condition acceptable to Department Architect

Appendix E

Gurney, Brian

From: Campbell, John [John.Campbell@northwestern.com]
Sent: Thursday, June 03, 2004 11:31 AM
To: Gurney, Brian
Subject: RE: Interconnection

Brian,

You have our blessing on the project. As we discussed, we won't need to net meter this project since the meter would never spin backwards. The only safety issue is to have an electric disconnect installed to prevent "islanding" the system (feeding electricity onto the grid when the Northwestern system is down).

As a side note, the chance of islanding is near impossible given the electronics in the new inverters. Also, the fuel cell would trip since it could not meet the load (the voltage would drop given the high current flow).

Thanks & good luck with your project.

John Campbell
Northwestern Energy
(406) 497-3364

-----Original Message-----
From: Gurney, Brian [mailto:BGurney@msubillings.edu]
Sent: Thursday, June 03, 2004 10:58 AM
To: Campbell, John
Cc: john.delvo@mdu.com; chris.denning@mt.ngb.army.mil
Subject: Interconnection

John,

We need a "green light" from you/NorthWestern Energy to move forward the Billings Armed Forces Reserve Center fuel cell installation. We anticipate installation in the next 3-4 weeks. Let me know how I can assist you.

Thanks,
Brian

Appendix F

Montana State University-Billings
&
Montana-Dakota Utilities Company

In Cooperation with the U.S. Army Corps of Engineers
& Montana Department of Military Affairs

Invites You To Attend

Fuel Cell Demonstration

Acceptance Ceremony

****

Tuesday, November 16, 2004

11:00 a.m. to 1:30 p.m

Billings Armed Forces Reserve Center
2915 Gabel Road, Billings, MT 59102
(near the new Shipton's Big R Store)

****

Join us for a tour, lunch, and ceremony related to one of the region's most technologically advanced energy research projects.

****

RSVP

Gary Amundson/Jane Hart, Center For Business Enterprise, College of Business
Montana State University-Billings, 1500 N. University, Billings, MT 59101
(406) 657-1610/657-2296; cell 861-1313 email gamundson@msubillings.edu or jhart@msubillings.edu

Parking in east lot at 29th/Gabel Road…Call or email for a map